

(19)



JAPANESE PATENT OFFICE

## PATENT ABSTRACTS OF JAPAN

(11) Publication number: **2003031374 A**(43) Date of publication of application: **31.01.03**

(51) Int. Cl.  
**H05B 33/26**  
**H05B 33/02**  
**H05B 33/14**

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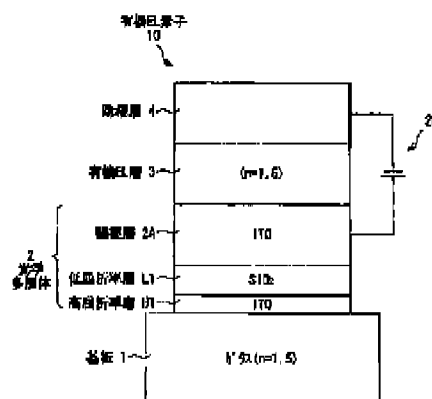
(54) **ORGANIC ELECTROLUMINESCENT ELEMENT**

## (57) Abstract:

**PROBLEM TO BE SOLVED:** To provide an organic electroluminescent element that can improve light takeout efficiency with simple constitution to improve brightness.

**SOLUTION:** This organic EL element 10 is provided with an optical multilayer body 2, an organic EL layer 3 and a cathode layer 4 in this order on one face side of a substrate 1, and a layer in contact with the organic EL layer 3 out of the optical multilayer body 2 is an anode layer 2A. The anode layer 2A has a higher refractive index than the organic EL layer 3 and functions as an anode of the organic EL element 10. The anode layer 2A is therefore formed of material what is called a high refractive index material with a refractive index  $n$  of almost 1.5 or more and simultaneously the material (such as ITO) allowing hole injection into the organic EL layer 3, and further has a sufficient thickness to function as an electrode.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is used for a display as a light emitting device, and relates to a suitable organic electroluminescence (EL; ElectroLuminescence) component.

[0002]

[Description of the Prior Art] Although the liquid crystal display was in use as a flat-panel display conventionally, in recent years, the organic electroluminescence display attracts attention as what attains the further pole thinning. Many organic EL devices are arranged and this organic electroluminescence display is constituted.

[0003] Moreover, if the laminating of a strip-of-paper-like anode plate layer, an organic electroluminescence layer, and the strip-of-paper-like catholyte is carried out to order and they apply an electrical potential difference among two poles at the whole surface side of a substrate, a current will be injected into an organic electroluminescence layer and electroluminescence will produce an organic EL device here. Usually, an anode plate layer and a substrate are transparent, and the light generated in this organic electroluminescence layer is taken out considering a substrate side as the screen.

[0004]

[Problem(s) to be Solved by the Invention] While light penetrates an anode plate layer and a substrate in that case, it is first reflected in part by the interface of an organic electroluminescence layer and an anode plate layer, and a part of light is further reflected also by the interface of an anode plate layer and a substrate, and the interface of a substrate and the air (open air) of the component exterior. Consequently, the light finally penetrated out of a component decreased to 7 - 80 percent of the original luminescence, and had the problem that brightness will be stopped low.

[0005] It is in offering the organic electroluminescence devices which this invention was made in view of this trouble, and the purpose raises the ejection effectiveness of light with a simple configuration, and can raise brightness.

[0006]

[Means for Solving the Problem] As for the organic electroluminescence devices by this invention, the layer to which an optical multilayer object, an organic electroluminescence layer, and catholyte are prepared, and touch an organic electroluminescence layer among optical multilayer objects at the whole surface side of a substrate also has a function as an anode plate (anode).

[0007] In the organic electroluminescence devices by this invention, in case luminescence in an

organic electroluminescence layer penetrates besides a substrate, the reflected light is reduced with an optical multilayer object.

[0008]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail with reference to a drawing.

[0009] Drawing 1 is the block diagram showing the outline of the organic EL device 10 concerning the gestalt of 1 operation of this invention. As for an organic EL device 10, the optical multilayer object 2, the organic electroluminescence layer 3, and catholyte 4 are formed in the whole surface side of a substrate 1 in order. In this organic EL device 10, the organic electroluminescence layer 3 and the touching layer are anode plate layer 2A among the optical multilayer objects 2. In addition, in this drawing, the drive circuit 20 for driving an organic EL device 10 is expressed as an equal circuit, and as shown in drawing, it is electrically connected to anode plate layer 2A and catholyte 4.

[0010] Substrates 1 are transparence substrates, such as thin film glass, and the optical multilayer object 2 is formed in the whole surface side. It is prepared in order that this optical multilayer object 2 may prevent the reflection in the interface of the organic electroluminescence layer 3 and a substrate 1, and while the laminating of the low refractive-index layer L with a low refractive index is carried out by turns and it consists of a high refractive-index layer H with a refractive index higher than the organic electroluminescence layer 3, and a high refractive-index layer, anode plate layer 2A which touches the organic electroluminescence layer 3 also has the function as an anode plate.

[0011] Therefore, anode plate layer 2A is equivalent to the high refractive-index layer H with a high refractive index to the organic electroluminescence layer 3, and functions as the anode plate of an organic EL device 10, i.e., an anode. Therefore, refractive indexes  $n$  must be about 1.5 or more so-called high refractive-index ingredients, and the ingredient of anode plate layer 2A must be an ingredient which can inject an electron hole into the organic electroluminescence layer 3 at coincidence. As such an ingredient, ITO used as an anode plate of an organic EL device is usually desirable. Moreover, the thickness is set as sufficient value to function as an electrode.

[0012] parts other than this anode plate layer 2A -- a substrate 1 side -- the high refractive-index layer H, the low refractive-index layer LH1, L1, and ... the laminating is carried out to Hk and Lk ( $k \geq 1$ ). Although, as for the reflection factor of the optical multilayer object 2, wavelength dispersion is equalized and there is a property top preferably so that the number of layers of this part is increased, thickness and productivity are considered and a proper number of layers is set up. Moreover, especially the ingredient of each class has the desirable refractive-index ingredient which does not affect the electrical characteristics of an organic EL device 10, but has translucency although not limited, for example, is ITO and Nb 2O5 as a high refractive-index layer H. As a low refractive-index layer L, it is SiO2. It can use. Furthermore, since the way where all layers consist of the same ingredient, respectively can simplify a configuration, the high refractive-index layer H containing anode plate layer 2A and the low refractive-index layer L have it. [ desirable ]

[0013] With the gestalt of this operation, the laminating of the high refractive-index layer H1, the low refractive-index layer L1, and the anode plate layer 2A should be carried out from the substrate 1 side in the structure of such an optical multilayer object 2. moreover, the high refractive-index layer H1 and anode plate layer 2A -- from ITO -- becoming -- the low refractive-index layer L1 -- SiO2 from -- it shall become In addition, the thickness of each class is called for by performing an optical design using the optical property ( $n$ ,  $k$ ) of a component. Table 1 is ITO and SiO2 which are the component of each class. The refractive index  $n$  and the extinction coefficient  $k$  are shown.

[0014]

[Table 1] ...

[0015] Here, an optical design is performed so that sufficient thickness for anode plate layer 2A may be given, at the same time the optical multilayer object 2 makes the reflection factor in an interface with the substrate 1 which consists of glass ( $n=1.5$ ) 5% or less as opposed to a light region with a wavelength of 400nm - 700nm. If an optical design is performed on such conditions, as for the thickness obtained, 41.53nm and anode plate layer 2A will be set [ the high refractive-index layer H1 ] to 139.82nm by 14.20nm and the low refractive-index layer L1.

[0016] On the optical multilayer object 2, the organic electroluminescence layer 3 which consists of an organic compound is formed. As for the organic electroluminescence layer 3, the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer (neither is illustrated) is carried out to order from the optical multilayer object 2 side.

[0017] An electron hole transportation layer is prepared in order to convey the electron hole poured in from anode plate layer 2A to a luminous layer. as the ingredient of an electron hole transportation layer -- benzene, a styryl amine, a triphenylamine, a porphyrin, triazole, an imidazole, oxadiazole, the poly aryl alkane, a phenylenediamine, arylamine, OKIZAZORU, an anthracene, and full -- me -- non, the monomer, the oligomer, or the polymer of heterocycle type conjugated system, such as a hydrazone, stilbenes, these derivatives or a polysilane system compound, a vinylcarbazole system compound, a thiophene system compound, or an aniline system compound, can be used. Specifically alpha-naphthylphenyl diamine, a porphyrin, a metal tetra-phenyl porphyrin, Metal naphthalocyanine, 4 and 4, 4-tris (3-methylphenyl phenylamino) triphenylamine triphenylamine, N, N, N, and N-tetrakis (p-tolyl) p-phenylene diamine, The N, N, N, and N-tetra-phenyl 4, 4-diamino biphenyl, N-phenyl carbazole, a 4-G p-tolylamino stilbene, Pori (PARAFENIREMBINIREN), Pori (thiophene vinylene), Pori (2 and 2-thienyl pyrrole), etc. are mentioned.

[0018] An electron and an electron hole are poured in from each of catholyte 4 and anode plate layer 2A, and a luminous layer is a field which these electrons and an electron hole recombine and emits light, when the potential difference arises between catholyte 4 and anode plate layer 2A. This luminous layer consists of organic materials, such as an ingredient with high luminous efficiency, for example, a low-molecular fluorochrome, a macromolecule of fluorescence, and a metal complex. Specifically, an anthracene, naphthalene, a phenanthrene, a pyrene, a chrysene, perylene, a butadiene, a coumarin, an acridine, a stilbene, a tris (8-quinolinolato) aluminum complex, a bis(benzoquinolinolato) beryllium complex, and the Tori (dibenzo ylmethyl) phenanthroline europium complex JITORUI ruby nil biphenyl are mentioned.

[0019] An electron transport layer is prepared in order to convey the electron poured in from catholyte 4 to a luminous layer. As an ingredient of an electron transport layer, a quinoline, perylene, bis-styryl, pyrazines, or these derivatives are mentioned, for example. Specifically, 8-hydroxy kino RINARU minium, an anthracene, naphthalene, a phenanthrene, a pyrene, a chrysene, perylene, a butadiene, a coumarin, an acridine, stilbenes, or these derivatives are mentioned.

[0020] On this organic electroluminescence layer 3, catholyte 4 is formed further. Catholyte 4 turns into an electrode layer (cathode) for injecting an electron into the organic electroluminescence layer 3. Aluminum (aluminum), an indium (In), magnesium (Mg), silver (Ag), calcium (calcium), barium (Ba), and a lithium (Li) are used, and these metals may be alone used for the ingredient, and may be used for it as an alloy with other metals.

[0021] This organic EL device 10 is the following, and can be made and manufactured.

[0022] First, a substrate 1 is prepared. All over the whole surface side of this substrate 1, for

example, the sputtering method is used and the high refractive-index layer H1, the low refractive-index layer L1, and anode plate layer 2A are formed in above-mentioned thickness in this order. Next, patterning of the anode plate layer 2A is carried out to a predetermined configuration, for example using the wet etching method. thus, three stratification of optical multilayer objects 2 is carried out -- sufficient -- moreover, all can be formed by the same membrane formation approach, and since the high refractive-index layer H1 and anode plate layer 2A were formed by ITO usually used for an anode plate, it can manufacture, without making a large change to a process.

[0023] That what is necessary is just to form the organic electroluminescence layer 3 and catholyte 4 in this order by the same approach (vacuum deposition method) as usual on anode plate layer 2A hereafter at a predetermined configuration, it does in this way and an organic EL device 10 is manufactured.

[0024] Next, actuation of an organic EL device 10 is explained. In an organic EL device 10, if the electrical potential difference of positive/negative is impressed to each of anode plate layer 2A and catholyte 4 from the drive circuit 20, an electron hole and an electron will be poured into the luminous layer in the organic electroluminescence layer 3 by the electric field produced among two poles, recombination will happen, and the so-called electroluminescence will arise. Although luminescence in a luminous layer is emitted isotropic, incidence of what was emitted to the substrate 1 side is carried out to a substrate 1 through the optical multilayer object 2.

[0025] Drawing 2 expresses the wavelength dependency over the wavelength of the incident light of the reflection factor in the optical multilayer object 2 of this organic EL device 10, and the interface of a substrate 1. With the gestalt of this operation, by establishing the optical multilayer object 2 designed as mentioned above, as shown in drawing, by the interface of the optical multilayer object 2 and a substrate 1, the reflection factor in a light region becomes 5% or less and a low thing. Thus, although the optical multilayer object 2 is at most three layers, it has the good acid-resisting function, and it is very as low as 2% or less. [ of especially a reflection factor with a wavelength of 430nm - 700nm ] the reflection of light by which incidence is carried out to this interface from a luminous layer is controlled by this, it is markedly alike compared with the former, and light is efficiently taken out from a substrate 1.

[0026] Thus, with the gestalt of this operation, since the optical multilayer object 2 was established between the organic electroluminescence layer 3 and the substrate 1, the reflection factor in the field by the side of the optical multilayer object 2 of a substrate 1 is reduced. Therefore, reflection [ in / in the light which generates in the organic electroluminescence layer 3 and is penetrated to a substrate 1 side / the interface of the optical multilayer object 2 and a substrate 1 ] is controlled. Therefore, the ejection effectiveness of the light by the side of a substrate 1 can improve, and the brightness of an organic EL device 10 can be raised.

[0027] Moreover, since it is not necessary to prepare an anode plate separately, and anode plate layer 2A of the optical multilayer objects 2 had the function as an anode plate and only the part of an anode plate can earn the number of layers and thickness of the optical multilayer object 2 conversely, a substantial thickness increment turns into only parts of the high refractive-index layer H1 and the low refractive-index layer L1. Therefore, the whole thickness can be stopped and it can consider as a simple configuration.

[0028] As mentioned above, although the gestalt of operation was mentioned and this invention was explained, this invention is not limited to the gestalt of the above-mentioned implementation, and can deform variously. for example, the organic EL device 10 mentioned with the gestalt of the above-mentioned implementation as shown in Drawing 3 -- receiving -- further -- a substrate 1 -- you may make it, attach the acid-resisting layer 5 to a side on the other hand (field which meets with the open air) This acid-resisting layer 5 is the optical multilayers

for preventing reflection of the light in the interface of a substrate 1 and the open air, and it is constituted especially except being the refractive-index ingredient which has translucency, without being limited. In addition, although the acid-resisting layer 5 may form membranes and form on the direct substrate 1, you may make it stick an acid-resisting film all over a substrate 1, and it can prepare it more easily. Thereby, the acid-resisting effectiveness by the side of the screen increases, and an organic EL device 10 becomes possible [ raising optical ejection effectiveness further compared with the gestalt of the above-mentioned implementation, or securing the acid-resisting effectiveness attained with the optical multilayer object 2 ].

[0029] Moreover, although the laminating of an electron hole transportation layer, a luminous layer, and the electron transport layer should be carried out in the organic electroluminescence layer 3 with the gestalt of the above-mentioned implementation, as long as the configuration of an organic electroluminescence layer is a configuration that it can function not only as this but as an organic EL device, it may be what kind of thing. For example, it is necessary to surely prepare neither of electron hole transportation layers and electron transport layers, and you may make it form the hole injection layer formed with the copper phthalocyanine, the porphyrin system compound, etc. between the electron hole transportation layer and the optical multilayer object 2. Moreover, the buffer layer which consists of Li<sub>2</sub>O etc. may be prepared between a luminous layer and catholyte 4.

[0030] Moreover, although the substrate 1 was used as thin film glass, it is desirable to use the substrate which has flexibility and you may make it use a high polymer film substrate from a viewpoint of a productivity drive or configuration workability with the gestalt of the above-mentioned implementation. The ingredient of such a substrate is a macromolecule polymer system ingredient which makes the start polyethylene terephthalate (PET;P oly (Ethylene Terephthalate).), a polycarbonate (PC-olyCarbonate), polyolefine (PO;PolyOlefin), polyether sulphone (PES;PolyEter Sulphone), etc.

[0031]

[Effect of the Invention] As explained above, according to the organic electroluminescence devices given in any 1 term of claim 1 thru/or claim 7 Since it was made for the layer which is the organic electroluminescence devices by which an optical multilayer object, an organic electroluminescence layer, and catholyte were prepared in the whole surface side of a substrate, and touches an organic electroluminescence layer among optical multilayer objects to also have a function as an anode plate The reflection factor by the side of the whole surface of a substrate decreases, reflection is prevented and the ejection effectiveness of luminescence from the organic electroluminescence layer which penetrates this field of light improves. Moreover, it is not necessary to prepare an anode plate separately, in spite of attaching the optical multilayer object, the whole thickness can be stopped, and a configuration can be made simple. Therefore, it becomes possible to raise the brightness of a component with a simple configuration.

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CLAIMS

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## [Claim(s)]

[Claim 1] They are the organic electroluminescence devices equipped with a substrate by which an optical multilayer object, an organic electroluminescence layer, and catholyte were prepared in the whole surface side of said substrate. Said optical multilayer object While the laminating of the 1st refractive-index layer with a refractive index higher than said organic electroluminescence layer and the 2nd refractive-index layer with a refractive index lower than said 1st refractive-index layer is carried out by turns and they are constituted Organic electroluminescence devices characterized by the layer which touches said organic electroluminescence layer among said optical multilayer objects having a function as an anode plate.

[Claim 2] Organic electroluminescence devices according to claim 1 characterized by using as said 1st refractive-index layer the layer which touches said organic electroluminescence layer among said optical multilayer objects.

[Claim 3] The layers which touch said organic electroluminescence layer among said optical multilayer objects are organic electroluminescence devices according to claim 2 characterized by consisting of indium tin oxide (ITO; Indium Tin Oxide).

[Claim 4] Said 1st refractive-index layer is organic electroluminescence devices according to claim 1 characterized by consisting of indium tin oxide.

[Claim 5] Said 2nd refractive-index layer is organic electroluminescence devices according to claim 1 characterized by consisting of a silicon dioxide.

[Claim 6] Said 1st refractive-index layer or said 2nd refraction layer is organic electroluminescence devices according to claim 1 characterized by being constituted above two-layer and forming all each class with the same ingredient.

[Claim 7] Furthermore, organic electroluminescence devices according to claim 1 characterized by the thing of said substrate for which a side is equipped with an acid-resisting layer on the other hand.

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[Translation done.]